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PATENT SPECIFICATION

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(54) A VALVE PROVIDED WITH LINEAR MOTORS

(71) I, NOBUYUKI SUGIMURA, of 1416 Sodeshi-cho, Shimizu-shi, Shizuoka-ken, Japan, of Japanese Nationality, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a valve assembly provided with linear motors.

According to the invention we provide a valve assembly comprising a valve body, a valve chamber provided in said body and having a fluid inlet port and a fluid outlet port, a valve member reciprocable in said chamber to control communication between said inlet port and said outlet port, and a pair of linear motors, as herein defined, disposed one at each end of the path of reciprocation of the valve member, the armature of each motor being connected to said valve member to impart movement thereto in response to energisation of the stator winding.

As used herein, the term "linear motor" refers to an induction motor having a linear stator and a linear armature, wherein the stator has a polyphase winding whereby a travelling magnetic field is generated in response to connection of said winding to a polyphase electrical power supply.

The invention will now be described by way of example with reference to the accompanying drawings and herein described.

Figures 1 to 4 are each longitudinal cross-sectional views of different embodiments of the present invention; and

Figure 5 is a fragmentary longitudinal sectional view of part of a valve member and the armature of a linear motor.

In the embodiment of Figure 1, a valve body 1 is provided with a liquid inlet port 2 and a pair of outlet ports 3. A spool 4 is received for reciprocation along a central cylindrical bore formed in the body to open or close the ports 3. A pair of linear motors A are provided one at each end of the valve body, each motor consisting of a stator 5 having a three-phase winding for producing a linearly travelling magnetic field and an armature 6 in the form of a rod which may be displaced linearly under the action of the magnetic field produced by the stator 5. Each armature 6 extends through a plate 10 closing the adjacent end of the valve body 1 and is connected with the adjacent end of the spool 4. A pair of springs 7 bias the spool 4 to a central position. When the linear motors A are de-energised, the spool occupies the position shown in Figure 1 in which both outlet ports 3 are closed.

The embodiment of Figure 2 is substantially the same as that of Figure 1 except that the configuration of the spool 4′ differs in that it increases in diameter progressively towards its enlarged ends, one of which ends is frusto-conically shaped. Also, the body is provided with only one outlet port 3.

The third embodiment of Figure 3 is identical to that of Figure 1 except that the stator 5 of one of the linear motors *A* is connected to a controller 8 which is adjustable to control the voltage or frequency of the electrical power supplied to the stator 5.

The embodiment shown in Figure 4 is substantially the same as that of Figure 2 except that the armature 6′ varies in cross-section along its length and has a narrowed portion which terminates in an enlarged portion at one end of the rod.

In the embodiment of Figure 5, the armature 6′ is provided, at one end thereof, with a magnetically-impermeable sleeve 9 having a varying outside diameter.

The operation of the valve of the present invention is such that, when, for example, the stator 5 of the linear motor *A* disposed on the right hand side of the valve body as viewed in Figures 1 to 4, is energised to produce a magnetic field the associated armature 6 or 6′ is forced to move to the left. The spool 4 is thereby moved to the left. Thus, in the embodiment of Figure 1, such movement of the spool will open the liquid outlet ports 3 to discharge liquid. On the other hand when the stator 5 of the linear motor *A* on the left hand side of the valve body is energised, spool 4 is moved to the right. Thus, the flow of liquid to and from the

valve may be controlled by the operation of the linear motors.

In the second embodiment shown in Figure 2, the spool 4′ may be moved in response to operation of the linear motors to open or close the liquid outlet port 3. In this instance, the cross-sectional area of the annular liquid passage formed by the inside wall of the central bore and inclined face of spool varies as the frusto-conical portion of the spool 4′ moves thereby controlling the degree of liquid flow.

In the embodiment of Figure 3, when the voltage or frequency of electrical current supplied to the stator 5 is varied by means of the controller 8, the velocity of the travelling magnetic field produced by the stator 5 is varied which in turn varies the velocity with which the associated armature 6 and the spool move in response to energisation of the linear motor *A*.

Where the cross-section of the armature varies as shown in Figure 4, or where it is provided with a magnetically-impermeable sleeve 9 as in Figure 5, the velocity of movement of the armature 6′ will also vary and operation of the spool 4′ will be governed by the velocity of the armature 6′.

WHAT I CLAIM IS:—

1. A valve assembly comprising a valve body, a valve chamber provided in said body and having a fluid inlet port and a fluid outlet port, a valve member reciprocable in said chamber to control communication between said inlet port and said outlet port, and a pair of linear motors, as herein defined, disposed one at each end of the path of reciprocation of the valve member, the armature of each motor being connected to said valve member to impart movement thereto in response to energisation of the stator winding.

2. A valve assembly according to Claim 1 wherein said chamber is cylindrical and said ports are provided in the cylindrical wall of the chamber, the valve member including a cylindrical portion coaxial with the chamber and being slidable axially of the chamber.

3. A valve assembly according to Claim 2 wherein the valve member includes a frusto-conically shaped portion extending from said cylindrical portion.

4. A valve assembly according to any one of Claims 1 to 3 including means for controlling the voltage or frequency of electrical power supplied to the stator winding of one of the motors.

5. A valve assembly according to any one of Claims 1 to 4 wherein each armature is of uniform cross-section along its length.

6. A valve assembly according to any one of Claims 1 to 4 wherein each armature is of varying cross-sectional area along its length.

7. A valve assembly according to any one of Claims 1 to 5 wherein each armature is provided with a sleeve of magnetically-impermeable material which extends over part of the length of the armature.

8. A valve assembly according to Claim 7 wherein the thickness of each sleeve varies along the length thereof.

9. A valve assembly substantially as hereinbefore described with reference to, and as shown in, any one of Figures 1 to 4 or Figure 2 as modified by Figure 5.

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Fig.1.

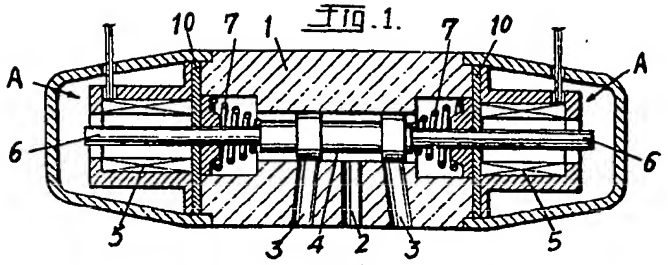

Fig.2.

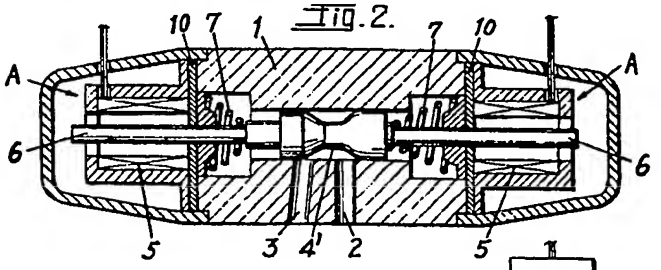

Fig.3.

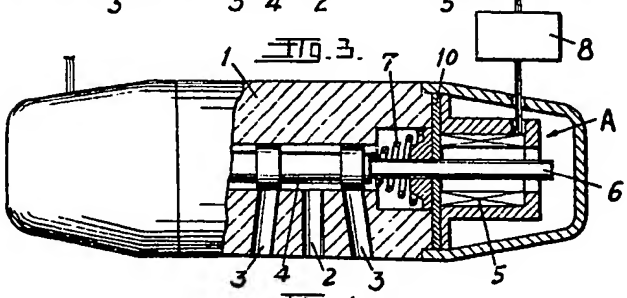

Fig.4.

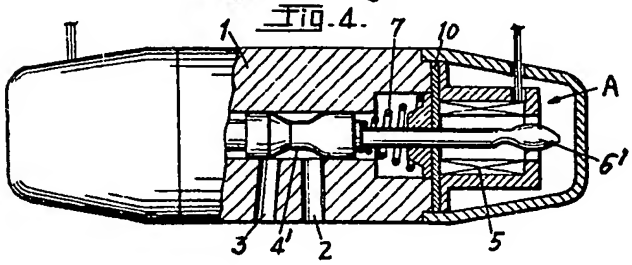

Fig.5.